APPLICATION OF SURFACE MINER IN INDIAN COAL MINES

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR
THE DEGREE OF

BACHELOR OF TECHNOLOGY
IN
MINING ENGINEERING

BY
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Under the Guidance of
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CERTIFICATE

This is to certify that, the thesis entitled "**APPLICATION OF SURFACE MINER IN INDIAN COAL MINES**" submitted by Sri Samrat Dutta in partial fulfillment of the requirements for the award of Bachelor of Technology degree in Mining Engineering at National Institute of Technology is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in the report has not been submitted to any University/Institute for the award of any Degree or Diploma.

Date: 10/05/2012

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An assemblage of this nature could never have been attempted without reference to and inspiration from the works of others. I acknowledge my indebtedness to all of them.

And my sincere thanks to the manager of Lakhanpur Opencast mines, Talabira mines and Vasundhara mines and to all my colleagues who have patiently extended all sorts of help for accomplishing this undertaking**.**

Date: 14/05/2012

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Discipline: Mining Engineering

CONTENTS

ABSTRACT

Conventional system of open cast mining of coal in India involves drilling, blasting and crushing which causes adverse impact on environment. It creates requirement of more machineries and manpower, ultimately cost of mining coal increases. Due to presence of villages near the mines, blasting is restricted as a result huge amount of coal is blocked. Quality of coal has great concern in our country because most of the coal seams contain inferior quality of coal due to drift origin. Government legislation also prohibits the dispatch of coal for more than 1000 Km if coal contains more than 36% ash. The introduction of surface miner under these conditions is capable to solve the above mentioned problems. It enables the operator of mine to ensure selective mining of coal as a result quality of coal improves. The multiplicity of thinner seams which are unworkable in conventional system of opencast mining becomes workable and the total reserve of non-renewable source of fossil fuel increases. It reduces cost of production as a result total profit of a mine increases.

OBJECTIVE:

- Impact of deployment of surface miner on economics of mine.
- Impact of deployment of surface miner on quality of coal.
- Assessment of environmental impact due to deployment of surface miner in the mine.
- Suitability for introduction of surface miner in Indian geo-mining conditions.

RATIONALE FOR THE STUDY:

Conventional system of opencast mining coal produces a lot of adverse impact on environment such as ground vibration, noise, dust, fly rock, air blast etc. It also needs large number of HEMM for drilling, blasting, excavating and crushing as a result requirement of machineries and manpower increases. These enhance cost of mining coal. Secondly in Indian geo-mining conditions large numbers of stone/dirt bands are present in coal seams. During blasting, these bands intermix with coal as a result quality is further deteriorated. Thinner coal seams are not workable in present conventional system of coal mining as a result non-renewable source of energy is wasted. Introduction of surface miner in Indian opencast coal mine solves all the above mentioned problems. Here surface miner cuts coal, size and loads in one single pass which eliminates the need of HEMM for drilling, blasting, excavating and crushing etc. By selective mining of thinner coal seams quality improves.

In our country population is very high and coal mines are surrounded by several villages which restricts blasting operation in the mine as a result huge amount of coal is blocked. Since demand of coal for producing electricity and other industrial purpose is very high which require alternative method to extract coal safely without affecting the villagers. The surface miner is one of the best alternative method of mining coal because it improves quality, reduce cost of production and environmentally friendly.

METHODOLOGY:

To fulfill the objective of this project, the following methodology is used.

- Literature collection.
- Collection of details (data) from 3 mines.
- Designing a MATLAB Program showing production appraisal comparison of any number of mines.

EXPECTED CONTRIBUTION FROM THE STUDY:

1. To compare the change in productivity of the mine after deployment of surface miner as compared to conventional system of mining coal.
2. To assess the reduction of adverse impact on environment after introduction of surface miner.
3. To find out the scope of working, non-workable seems by introduction of Surface miner.
4. To assess the improvement in standards of safety after introduction of surface miner.
5. To make the mine operator aware of various advantages of mining by surface miner as compared to conventional system of mining.
6. To assess the improvement in quality of mined out coal by surface miner as compared to conventional system of mining.

LIMITATIONS:

The study in question may suffer from the following limitations:-

1. This study is limited to a particular geo-mining condition.
2. Study is limited to 2100 SM and 2200 SM model of Wirtgen surface miner. The cost and production will vary with different model.

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CHAPTER 1

INTRODUCTION

INTRODUCTION:

With a critical mass of progress in regulatory reforms and soaring economic growth, the Indian Power Sector is now primed for takeoff. How India deals with the remaining challenges of the re-structuring process and emerging fuel shortages will dictate what happens in the years to come. India has set itself an ambitious target of more than doubling per-capita electricity consumption by 2011. India's coal demand is expected to grow 7% annually over the next decade. Much of this increased demand will come from power generation, which currently accounts for about 80% of total coal consumption. For a country that has relied heavily on domestic coal, the stresses of such a demand growth are already apparent. Over the last decade, coal imports have steadily risen at an annual rate of 12%. The expected coal demand by the terminal year of XIth Five Year Plan is only 650 MT. To meet this challenge, technology up-gradation, apart from opening new mines, is the need of the hour. Surface Miner technology has a huge potential of enhancing coal production from existing mines as well as new mines.

India is the third largest coal producing country in the world and about 88% coal production comes from open cast mining. The conventional system of mining coal by open cast method involves drilling, blasting, excavating and crushing. The HEMM involves in different process are Shovel, Drill m/c, Dozer, Dumper, Dragline, Grader etc. Here mining operations are invariably associated with terminal effect of land degradation, ecological disturbances, noise and air pollution and consequent upon overall environmental deterioration. Blasting operation on a large scale give rise to blast-induced ground vibrations, air-blast, fly rock, blasting fumes, dust cloud, noise, disturbance to water regimes., and damage to nearby structures. Drilling and crushing operations also cause a lot of hazardous environmental disorder and damaging effects such as air and noise pollution. The quality management in Opencast coal mines with the layers of grey shale/carbonaceous shale, stone bands, dirt bands etc has become a difficult task by conventional method of mining. These

factors have prompted the mining community to look for a non conventional method and to increase "**QUALITY PRODUCTION"** and productivity while meeting the requirement of being environmentally safe operations. This was the back ground for the epoch making introduction of **'Wirtgen Surface Miner'** at Lakhanpur Opencast Project of Mahanadi Coalfields Limited, in Orissa for the first time in the history of coal mining Industry in India on 21st June, 1999.

CHAPTER 2

LITERATURE REVIEW

Project Profile of 3 mines

General description of surface miners

Concept of surface miner

Uses of surface miner

Application of surface miner

Cuttability classification for surface miners

Working principle of surface miner (2100/2200 SM of Wirtgen)

Factors affecting productivity of surface miner

Machine Details of various surface miners

Project Profile of 3 mines

a> ***Lakhanpur mines***

1.	Mineable reserve		: 416.32 MT
2.	Targeted production (Coal)		:15 MT
3.	Stripping ratio (Avg.)		: 2.34
4.	Average thickness of the seam		: 25-32 m
5.	Gradient		: 1 in 18 to 1 in 10
6.	Maximum depth of quarry		: 165m
7.	Project life		: 25 years.
8.	Capital Cost		
		As per P R	: 355.86 Rs/Te
9.	Manpower requirement		
		As per P.R.	: 1469
		Actual-	: 829
10.	OMS	As per P.R.	: 29.09
		Actual-	: 37.83
11.	Quality of Coal		
		As per P R	: Gr. F 87%, Gr. G- 13%
		Actual	: Gr. F
12.	Main Customer		: ITPS (OPGC)
			: TNEB
			: WBPDCL
			:MAHAGENCO

13. Profitability

2009-10	:195.85 Crore
2010-11	:48279.43 Lakh

GEOLOGY of Lakhanpur Mines:

There are five coal seams in the sub-block considered for the open cast mining. They are (1) Belpahar (2) Parkhani (3) Lajkura (4) Rampur and (5) IB Seam in descending order. In the area chosen for open cast mining under the Project Report for Lakhanpur OCP, only Lajkura seam is proposed to be worked where the upper seams do not exists. The two seams (Rampur and IB) beneath Lajkura occur with large parting and these could be worked by underground method after exhausting the Lajkura seam. The available dirt bands 1 to 5 in numbers are combustible (carb shales) and 1.47m to 6.91m in thickness. One such thick band persists in the lower half of the seam throughout the block. Thickness of bands tend to increase towards south as well as towards west of the property.

REASONS FOR DEPLOYMENT OF SURFACE MINER AT LAKHANPUR OCP.

The idea of deploying surface miner at Lakhanpur Open Cast Project was conceived considering the following points.

-Improvement of quality by selective mining of coal: Coal is interspersed with shale and sand stone of varying thickness for which the product from the mine was marketed as Gr. F. The presence of these bands 1 to 5 Nos. is the major concern for quality deterioration of coal seam.

-Eco-Friendly mining of coal: Drilling and blasting operation at large scale produces a lot of noise, dust, vibration, fly rock formation etc. The crushing of coal needs major infrastructure, space and man power, thus producing loud noise, dust, vibration etc. This has prompted the mining community to look for a viable alternative of rock breakage for overcoming these

deficiencies and to increase the production and productivity while meeting the requirement of environmentally safe operation.

-Proximity of Ghanamal, Tingismal, Khairkuni, and Khunt Mahal Villages: These villages are located within the mine boundary. Due to restriction imposed by Directorate of Mines Safety, Bhubneshwar Region for carrying out blasting operation beyond 150 m from the structure resulted in locking up of huge amount of coal.

-No washing of coal is required to improve quality of coal.

-Tech. no-economically the coal from surface miner will be cheaper in view of the size of coal produced within the range of (+) 20 mm to (-) 100 mm which does not require secondary crushing.

Fig. 2.1: Accident statistics of Lakhanpur Mines

b> ***Talabira Mines***

1.	Mining Lease Area	170.305 Ha
2.	Coal Bearing Area	89 Ha
3.	Active Mining Area	55 Ha
4.	Recoverable Coal Reserve	23.50 MT
5.	Grade of Coal	F & G
6.	Workable seams	7
7.	Use of coal	Captive Power Plant at Hirakud
8.	Average Stripping Ratio	1.09 cum/ton
9.	Dip of Seam	5^{o}-10^{o}
10.	OMS	31.56
11.	Thickness range of seams	0.70 M to 44.69 M
12.	Maximum OB on Top Seam	23 mt
13.	Maximum depth to be mined	90 mt
14.	Average Coal Quality(GCV)	3250 Kcal/Kg(Gr-F)
15.	Distance of end use power plant	45 Km

Geology of Talabira Mines

Talabira Block-1 constitutes the south eastern end of Ib valley coalfield. The area of the block allocated is 2.60 sq. km. and the HINDALCO lease are is 1.703 sq. km. the remaining 0.89 sq. km of land belongs to forest, Private and to Department of Water Resources. The block is situated in Sambalpur District of Orissa State between latitude $21^{0}42'58''$ to $21^{0}44'37''$ North and longitude $83^{0}58'51''$ to $84^{0}00'39''$ East. Talabira Block-1 forms a separate sub-basin.

Name of the Seam	Range of Depth	Parting in Mtrs.	Thickness in Mtrs.	Direction of Dip	Rate of Dip	Nature of Overburden
Rampur Top	8-54		35.90 to 44.69	Towards centre (NW-SE trending elongated synclinal sub-basin)	5^0 to 10^0	Top soil Boulder clay
Rampur bottom-III	6-60	2 to 5.32	0.44-2.76		5^0 to 10^0	Sandstone & Shale
Rampur bottom-II	6-66	0.71 to 6.15	0.44-3.01		5^0 to 10^0	Sandstone & Shale
Rampur bottom-I	6-74	0.3 to 3.42	0.24-5.57		5^0 to 10^0	Sandstone & Shale
IB-III	18.37-82.71	2.34	0.4-3.83		5^0 to 10^0	Sandstone & Shale
IB-II	32-92.00	2.66	0.14-2.07		5^0 to 10^0	Sandstone & Shale
IB-I	36-98		0.25-2.64		5^0 to 10^0	Sandstone & Shale

Table 2.1: Table showing details of seam specification

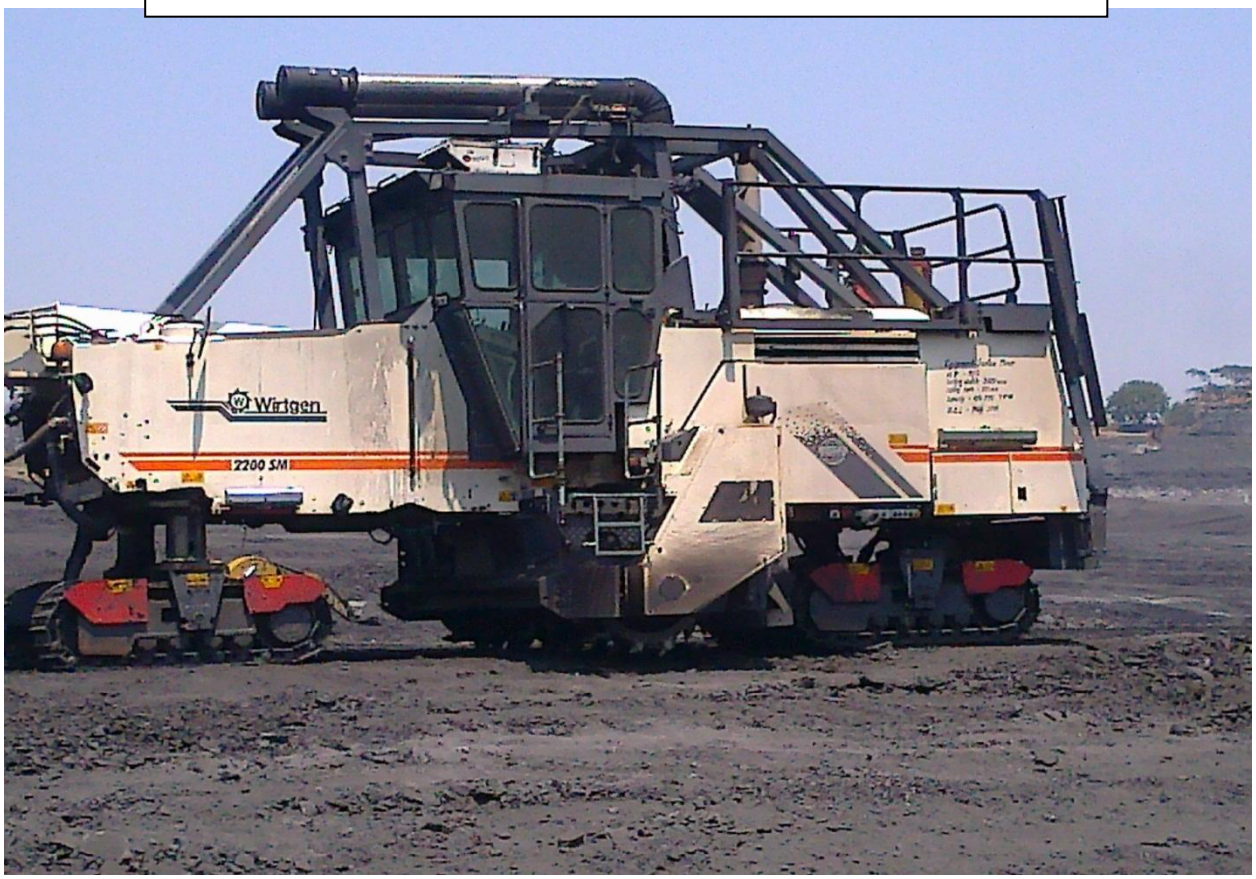


Fig. 2.2: Surface miner of Talabira mines

c> *Basundhara Mines*

(a) Project Boundary

North & East Block boundary passing through the north of borehole numbers CMHG-171, CMHG-174, CMHG-134, CMHG-347, CMHG-344, CMHG-168, CMHG-187, CMHG-304, CMHG-161, CMHG-163 and CMHG-150

South Defined by northern bank of Basundhara river.

West Defined by eastern bank of Basundhara nallah

The core zone of the project comprising of excavation zone, infrastructure area, OB dump sites, safety zone for blasting, etc., covers partly and/or fully the land from three (3) villages namely, Sardega, Tiklipara and Kulapara basti of Gopalpur Village. Total 523 families from Sardega (207), Tiklipara (258) and Kulapara (58) have been affected. Employment has been given to 292 families: from Sardega village (115), Tiklipara (177) and Kulapara (24). The rehabilitation site is Basundhara Nagar (Tiklipara). Total no of plots are 260. 256 no of plots have been allotted to the families of Sardega (124) and Tiklipara (132) villages. R & R have been completed for Sardega and Tiklipara village. For Kulapara, R & R will be completed in all respect after providing about 5 no. of employments in MCL shortly.

Life of the mine: 2013

Manpower requirement is 603 including existing manpower of 447 persons.

Total capital investment is Rs. 129.08 crore

EMP capital investment is Rs. 21.76 crore

Geology of Vasundhara Mines

(i) A total of 3582.20 meters of drilling in 66 boreholes have been carried out in the area with a borehole density of 35 per sq.km.

(ii) Two coal seams (Ib seam & Rampur seam) will be worked in this project. The grade of coal is F (Avg.)

(iii) The mineable reserve is 44.32 million tonnes (as on 01.04.2006).

Hydrogeology:

Ground water in the area occurs under both unconfined and confined conditions. The weathered mantle, recent alluvium and laterites act as unconfined aquifer or phreatic aquifer. Underlying aquifers mainly consist of conglomerates and sandstones and are interbedded with aquitards or aquicludes, which are comprised of mainly shales and coal seams. The depth of water level ranges from less than 2 m to about 15 m and fluctuation of water levels range from 2 to 12 m in the area.

General description of surface miners

Basically three types of Surface Miner are available in the market today. Pictorial view of each type Surface Miner machine is given below:

a) Machines with front boom cutting drum

Fig. 2.3: Machines with front boom cutting drum

b) Machines with middle drum configuration. Schematic drawing of Machine with middle drum configuration is given below:

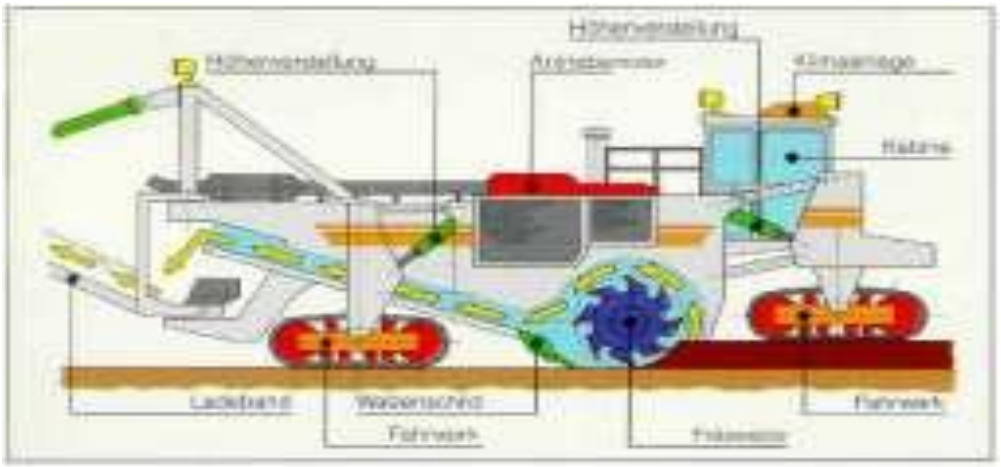


Fig. 2.4: Pictorial view of Surface Miner Machine with middle drum configuration in discontinuous transport with truck system is given below:

Fig. 2.5: Machines with middle drum configuration

c) Machines with front cutting wheel. Pictorial view of this machine is given below:

Fig. 2.6: Machines with front cutting wheel

Concept of Surface miner

Concept of surface miner is to cut, crush and load in one pass. In conventional method, drilling, blasting, crushing and loading are done in three different operations and as such it is costly and time consuming process.

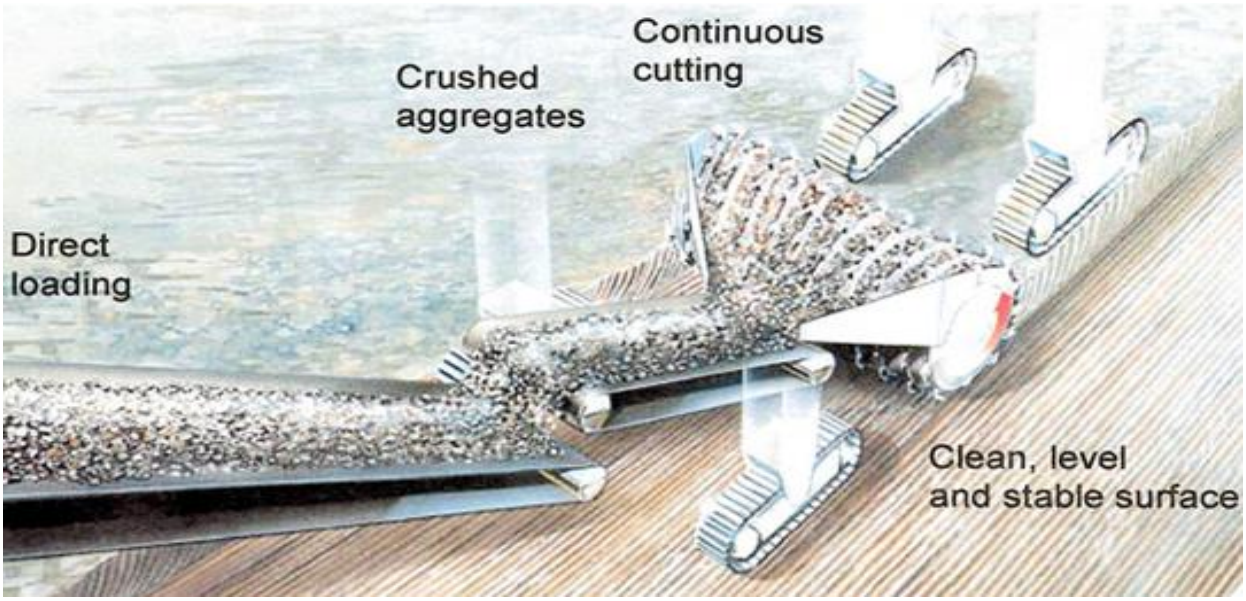


Fig. 2.7: CUT, CRUSH AND LOADING IN ONE PASS

Uses of Surface miners

Surface miners can be used for the achieving the following final products:

(a) Desired materials.

Of course the most common end product is a selected material cut, crushed and loaded to haul in one process. Using the surface mining process, you can achieve higher productivity with less cost and less equipment. Also under this concept, you have can mine safety without the environmental issues.

Fig. 2.8: Machine depicting transfer of desired material

(b) Clean usable surfaces.

Clean, stable surfaces are another benefit of surface mining technology. Several customers have us surface mine entrances to their mining or construction operations. This simple service allows safe hauling and prevents damage to other equipment used in everyday mining and construction conditions.

Fig. 2.9: Figure showing clean usable surfaces

(c) Ramps.

Ramps needed for highway and road construction are other examples of finished products of surface mining. Because the machines operation can be programmed and optional laser guided and GPS navigation can be added, the surface miner can make precise fixed or variable cuts to meet custom engineering needs.

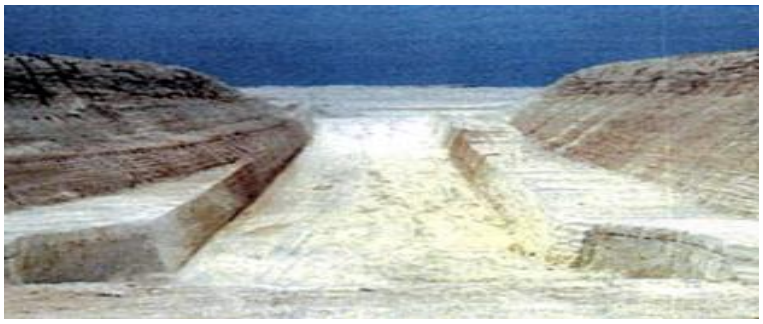


Fig.2.10: Figure showing ramp

(d) Highwalls.

The surface miner can also produce solid highwalls. Conventional methods such as drilling and blasting can loosen material on highwalls. As the pictures on the right clearly show, highwalls created by our surface miners are stable, precise and clean. No more danger of falling material into the roadway. Surface Miners can create a safe working environment next to highwalls.

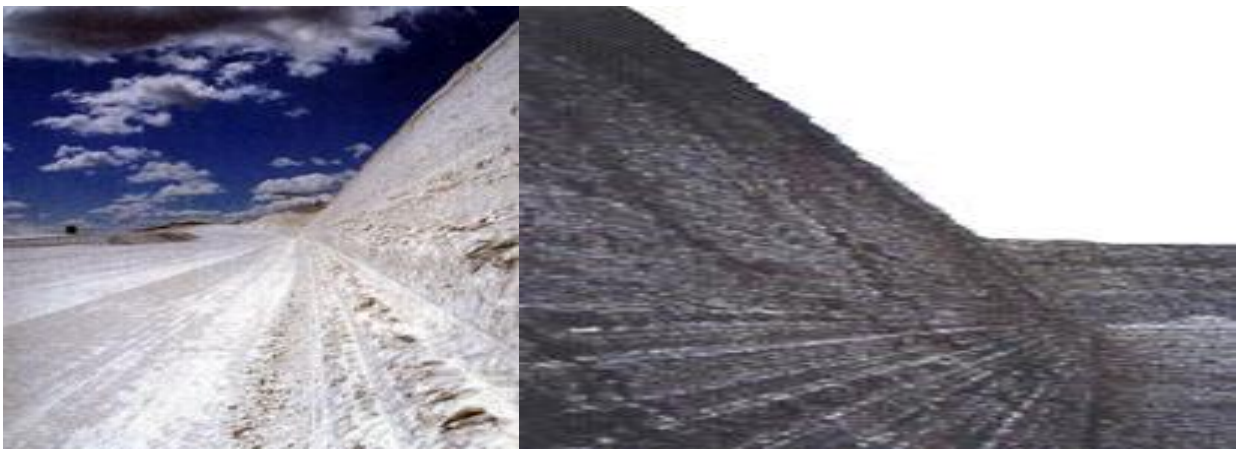


Fig.2.11: Figure showing highwalls

(e) Trenching.

A prime example of finished products would be trenching. Trenching roads and under-passes can be timely and expensive. But our surface miner can offer a clean, smooth and stable surface on time and under budget, which cannot be achieved by conventional methods of mining.

Fig. 2.l2: Figure showing Trenching

Application of Surface miners

Surface Miners can be used in discontinuous and continuous open cast mining systems. The most common type of application is probably a system that uses trucks for transport of the material. Direct combinations of Surface Miners with conveyor systems are also possible, as well as mixed systems where the trucks are used on short cycles to transport the material to a semi-mobile loading station for further conveyor transport.

The following sections describe in detail some example applications

- *Discontinuous transport with trucks*

The operation between the Surface Miners and trucks is similar to an open cast mining system operating with rope shovels or wheel loaders. For optimization of the Surface Miners-open cast mine system, the following points should be considered during operation.

-During loading, the trucks are positioned parallel to the Surface Miners. The truck traffic should be organized in such a manner that the trucks arrive and depart parallel to the Surface Miners without shunting, turning or backing up.

-The capacity of the truck body should be chosen in such a way that during normal operation, the truck stands still while the Surface Miners moves forward and loads the truck uniformly over the whole length. A uniform loading of the trucks ensures minimum operating costs.

-The most favorable operating conditions are a relatively long and even bench. At the end of the bench, sufficient space should be available for turning and ramping in and out of the cut.

-A situation frequently encountered in open cast mines is the mining of inclined seams or partings. Such an adaptation to the deposit is easily possible up to an inclination of 6° in the longitudinal and 5° in the transverse directions.

For this type of operations the economics are - system have to be compared with either shovel or wheel loader systems, which could perform the same job.

Comparison of Specific Cost

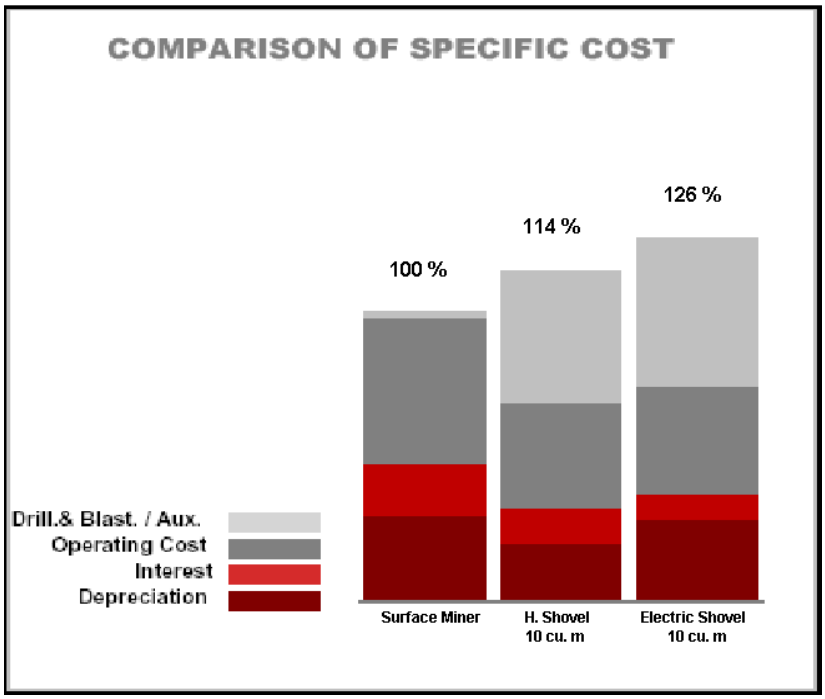


Fig. 2.13: Figure showing comparison of specific cost

This economy cost calculation shows clearly the tendencies for application of the surface miner. The machine is advantageous in mines where drilling and blasting is required and where this cost have a sufficient amount within the total mining system. Two figures which are also decisive for surface miner applications have not been considered within this calculation because they will vary very much within different mine sites

- the costs for crushing of pay mineral and
- the additional benefits which are gained from the selective operation itself, specially the higher yield of product, less dilution of product compared to blasting and less creation of fines.

Cuttability classification for surface miners

A new rockmass classification system is simplistically developed considering the key influencing parameters, namely, point load strength index and volumetric joint count. Influence of rock abrasivity and direction of machine operation with respect to joint direction are also considered. Considering the high power machine can cut a relatively stronger rock, the engine power of the cutting machine is also rated in this classification. The rating of these parameters are tabulated below –

Table 2.2: Table showing about Is.Jv,Aw,Js,M ranges

Class	I	II	III	IV	V
Point load index (I_s50)	< 0.5	0.5 – 1.5	1.5 – 2.0	2.0 – 3.5	> 3.5
Rating (I_s)	5	10	15	20	25
Volumetric joint count (no/m^3)	> 30	30– 10	10 – 3	3 – 1	1
Rating (J_v)	5	10	15	20	25
Abrasivity	< 0.5	0.5 – 1.0	1.0 – 2.0	2.0 – 3.0	> 3.0
Rating (A_w)	3	6	9	12	15
Direction of cutting respect to major joint direction	72^0 - 90^0	54^0 - 72^0	36^0 - 54^0	18^0 - 36^0	0^0 - 18^0
Rating (J_s)	3	6	9	12	15
Machine power (kW)	> 1000	800 – 1000	600 – 800	400 – 600	< 400
Rating (M)	4	8	12	16	20

So the new cuttability index (CI) = Is+Jv+Aw+Js+M

As per cuttability index we can rate the excavatability of surface miner as follows-

Table 2.3: Table showing excavatability index and its possibility of ripping

Excavatability index	Possibility of ripping
$50 > CI$	Very easy excavation
$50 < CI < 60$	Easy excavation
$60 < CI < 70$	Economic excavation
$70 < CI < 80$	Difficult excavation, may be not economic
$CI > 80$	Surface miner should not be deployed

Similarly by this we can find the production rate of surface miner by the following formula-

$$L^* = \left(1 - \frac{CI}{100}\right) k M_c$$

Where L* = production or cutting performance (bcm/h)

Mc = rated capacity of the machine (bcm/h)

CI = cuttability index

K = a factor for considering of influence of specific cutting condition and is a function of pick lacing (array), pick shape, atmospheric condition etc. and

varies from 0.5 – 1.0.

WORKING PRINCIPLE OF SURFACE MINER (2100/2200 SM OF WIRTGEN) :

The surface miner is provided with a drum shaped cutting or milling head fitted with a number of tungsten carbide tipped replaceable picks extending across the full width of the machine in the form of a helix which facilitates propelling of the cut materials towards the centre of the machine. The cutting drum is located between the two sets of crawlers and is centrally positioned making the machine compact. The milling drum is mechanically driven by the direct drive system through V-belting directly via a mechanical clutch on the fly wheel side of the diesel engine. The milling drum holds cutting tool holders welded on the drum body and cutting tools are fixed on to these holders by clip.

The milling drum operates in up-milling direction and cuts the material slice –by- slice on the floor of the bench. The cut materials are picked up by a tool and flight system centrally on the primary conveyor belt which during transportation further reduces the size of the material. The primary belt conveyor further transports the material to the secondary conveyor, which in turn loads the material finally onto the trucks or side casted in the mine. The cutting drum is followed by a scraper blade which gathers any material left on the floor. This ensures a clean and smooth floor without any undulations. Dust suppression is ensured by means of water spray

arranged on cutting drum, which also serves the dual purpose of cooling the picks, thus enhancing their usual life while leaving the working environment totally dust free.

The surface miner has two sets of crawlers; each individual crawler unit in front set has its own steering cylinder facilitating negotiation on the sharp turns. Each crawler unit and the cutting head can be raised or lowered by means of hydraulic cylinders provided for the purpose. The surface miner is equipped with an air –conditioned operator's cabin, which has all machine controls within comfortable reach of the operator. The depth is adjusted by setting the number through electronically controlled depth regulator located at the side of the machine. The surface miner is also equipped with flood light for night operation.

Optimum working length:

The optimum working length differs very much depending on the travelling speed and hardness of the rock. In harder rock, where the travelling speed is low (e.g.5m/min), the optimum working length is approx. 250 m for 2100 SM. In soft material, where the travelling speed is high (e.g. 20m/min), the optimum working length is approx. 900 m and even more.

Machine Operation:

The machine is operated by an operator inside the cabin who is responsible for smooth operation and control of the machine. The operator in the cabin controls the speed, position of the belt conveyor for proper loading into the tippers.

The machine normally loads on to tippers directly by slewing the belt conveyor. In case of failure of the mechanism of belt conveyor, the machine can produce coal by windrowing operation. In windrowing, the machine moves at a faster rate and cuts the slices and leaves behind conical section of cut coal which can be loaded by deploying pay- loaders on to the

tippers. The efficiency of machine improves in windrowing operation, so, in Lakhanpur OCP coal is being loaded by pay loader into tippers/hywas after windrowing operation.

Factors affecting productivity of surface miner

As per cuttability index, productivity of surface miner mainly can be affected by following ways-

- ***Point load index***

  It is an index to determine strength of hard rock materials. It is influenced by sample size.

- ***Volumetric joint count***

  It is defined as the sum of the number of joints per meter for each set present, and is measured along the joint set perpendicular.

- ***Abrasivity***

  If the abrasivity increases there will be decrease in performance of surface miner

- ***Cuttability***

  Performance of surface miner depends on cuttability index, as the cuttability index increases performance of surface miner decreases. If the cuttability index exceeds greater than 80, surface miner should not be deployed.

- ***Machine Configuration***

  Performance of surface miner depends on machine configuration such as cutting tool configuration, drum weight, drum width, engine power, nature of coolant for tips.

Machine Details of various surface miners

Table 2.4: Table showing machine details of different surface miner companies

	Parameters	Drum width (m)	Machine power (kW)	Operating weight (ton)	Rated capacity (m^3/h)	Cutting depth (mm)	Maximum cutting speed (m/min)	Operating gradient (1 in x)
Wirtgen GmbH	SM 2100	2.0	448	41	550	250	25	6
	SM2200	2.2	671	49	668	350	84	6
	SM2500	2.5	783	100	845	600	25	7
	SM3500	3.5	895	137	1900	470	25	12
	SM4200	4.2	1194	184	2400	600	20	5
Vermeer	T855	2.5	281	40.8	NA	812	28	NA
	T955	3.4	309	56.7	NA	812	20	NA
	T1055	3.4	317	61.2	NA	812	16	NA
	T1255	3.7	447	99.8	NA	610	12	NA
L & T	KSM223	2.2	597	NA	NA	350	83	8
	KSM304	3.0	895	100	NA	400	20	5
TAKRAF GmbH	MTS180	3.3	500	NA	180	700	NA	NA
	MTS300	4.0	750	NA	300	875	NA	NA
	MTS500	4.9	1650	NA	500	1050	NA	NA
	MTS800	5.6	2000	NA	800	1225	NA	NA
	MTS1250	6.5	2500	NA	1250	1400	NA	NA
	MTS2000	7.4	2500	NA	2000	1575	NA	NA
Bitelli	SF202	2.0	515	43	180	250	NA	NA

CHAPTER 3

Development of Computer Program Using MATLAB

Case Studies taken for programming from 3 mines

Flowchart

Program Code

Output

Development of Computer Program Using MATLAB

In this Program, the performance appraisal comparison of different mines has been done using MATLAB Programming Language.

CASE STUDIES TAKEN FOR PROGRAMMIING

The field investigations have been carried out in 3 sites-

I. Lakhanpur Opencast Project of MCL

Point load index = 1.1 i.e. rating Is = 10

Surface Miner used == 2100 SM

Rated machine capacity = 400 m3/h

Machine power = 448 kW i.e. rating Mc = 16

Volumetric joint count = 32 i.e. rating Jv = 5

Abrasivity = 0.4 i.e. rating Aw = 3

Direction of machine operation with respect to joint plane = 80◦ i.e. rating Js = 3

Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 37 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 37/100) × 400 × 0.6 = 151 m3/h

Density = 1.4

Expected production achieved = 210 t/h

II. Basundhara Opencast Project of MCL

Point load index = 1.2 i.e. rating Is = 10

Surface Miner used == 2200 SM

Rated machine capacity = 300 m3/h

Machine power = 596.5 kW i.e. rating M = 16

Volumetric joint count = 28 i.e. rating Jv = 10

Abrasivity = 0.6 i.e. rating Aw = 6

Direction of machine operation with respect to joint plane = 90◦ i.e. rating Js = 3

Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 45 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 45/100) × 300 × 0.6 = 99 m3/h

Density = 1.4

Expected production achieved = 138.6 t/h

III. Talabira Opencast Project of MCL

Point load index = 1.15 i.e. rating Is = 10

Surface Miner used = 2200 SM

Rated machine capacity = 428.5 m3/h

Machine power = 591 kW i.e. rating M = 16

Volumetric joint count = 29 i.e. rating Jv = 10

Abrasivity = 0.6 i.e. rating Aw = 6

Direction of machine operation with respect to joint plane = 80◦ i.e. rating Js = 3

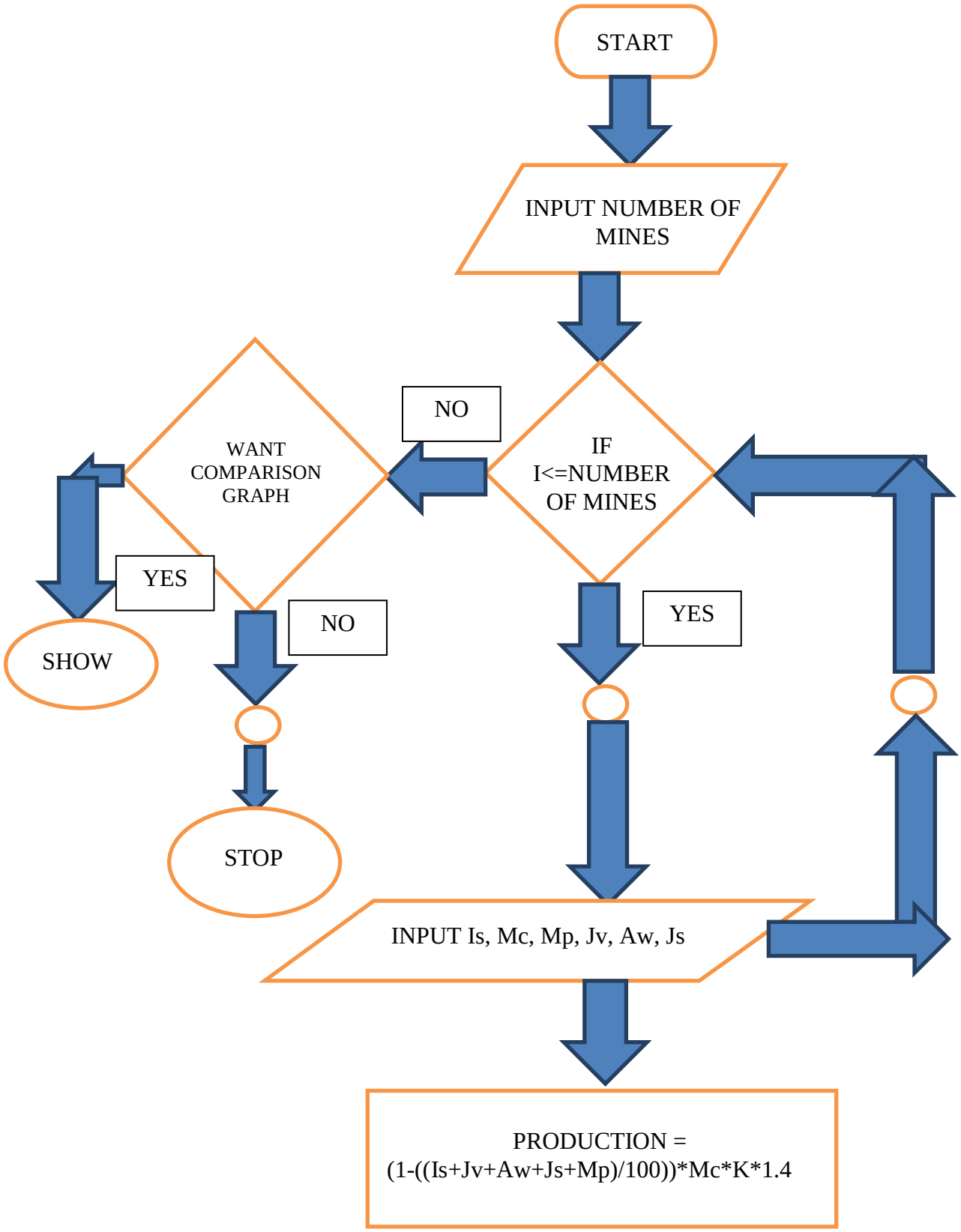
Thus, cuttability index (CI) = Is+Jv+Aw+Js+M = 45 (thus very easy cutting condition for surface miner)

Expected production (for k = 0.6) = (1 – 45/100) × 428.5 × 0.6 = 141.405 m3/h

Density = 1.4

Expected production achieved = 197.967 t/h

3.1: Flowchart



3.2:Program Code

```
clc;
prompt = {'Enter no. of mines you want to compare:'};
dlg_title = 'Input for no. of mines';
num_lines = 1;
answer = inputdlg(prompt,dlg_title,num_lines);
no_of_mines=str2num(answer{1});
% disp(no_of_mines);
expected_production=zeros(1,no_of_mines);
for i=1:no_of_mines
disp(['INPUT DETAILS FOR MACHINE NO. ' num2str(i)]);
prompt = {'  Enter point load index rating(Is):','Enter the rated machine capacity in m3/hour(Mc)','Enter the machine power rating(Mp)','Enter the volumetric joint count rating(Jv)','Enter the Abrasivity rating(Aw)','Enter the rating for the Direction of machine operation with respect to joint plane(Js)','Enter the k value i.e. the factor influencing specific cutting condition=k'};
dlg_title = 'Input for machine';
num_lines = 1;
answer = inputdlg(prompt,dlg_title,num_lines);
Is=str2num(answer{1});
Mc=str2num(answer{2});
Mp=str2num(answer{3});
Jv=str2num(answer{4});
```

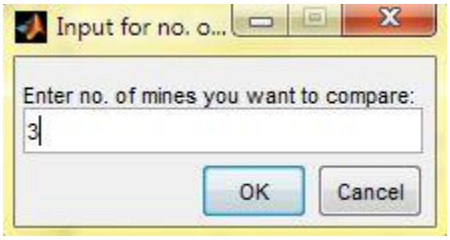
```
Aw=str2num(answer{5});
Js=str2num(answer{6});
k=str2num(answer{7});
ep=(1-((Is+Jv+Aw+Js+Mp)/100))*Mc*k*1.4;
expected_production(1,i)=ep
end
bases=[1:1:no_of_mines];
choice = questdlg('Do you want to make comparision:', ...
          'Options Menu', ...
          'Yes','No','No');
switch choice
   case 'Yes'
      figure; bar(bases,expected_production,0.4);
      xlabel({'Mines Number '});
      ylabel({' Expected Prdouction (Tonns/Hour)  '});
      title(' Mines using Surface Miner ',...
           'FontWeight','bold')
        Options=1;
      break
   case 'No'
      disp([choice ' coming right up.'])
      dessert = 2;
     break
```

```
    case 'No thank you'
        Options=0;
end
```

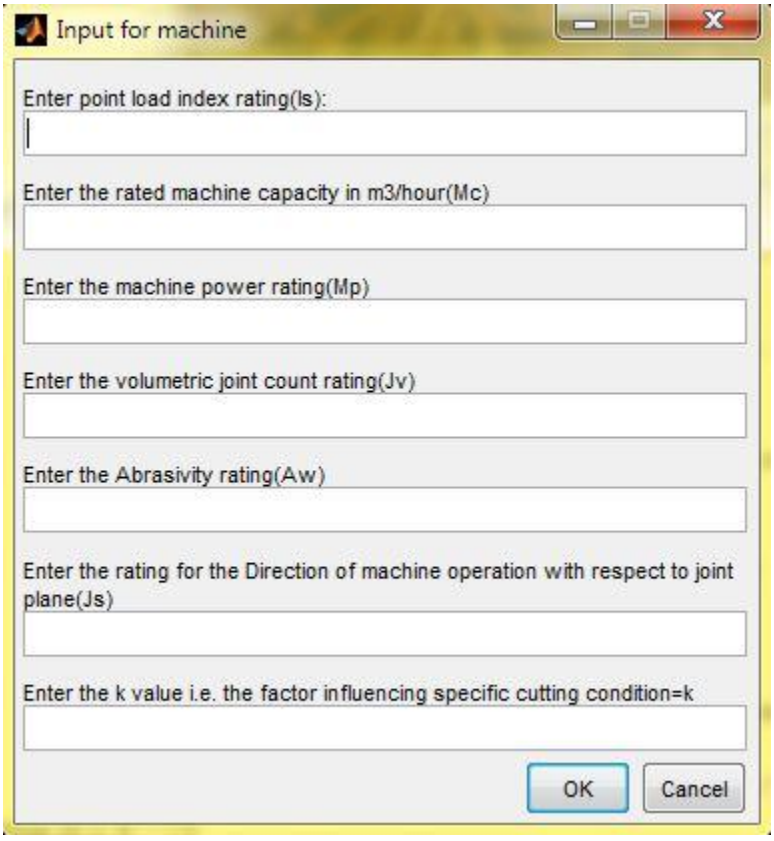
3.3: OUTPUT

- Initially we need to input the number of mines to compare

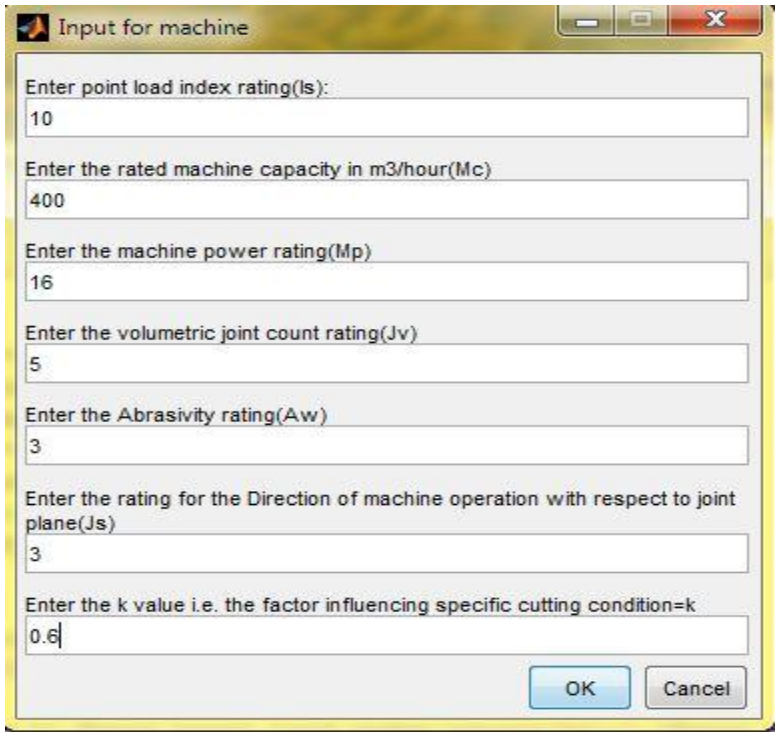
- While putting the value the output file shows like this

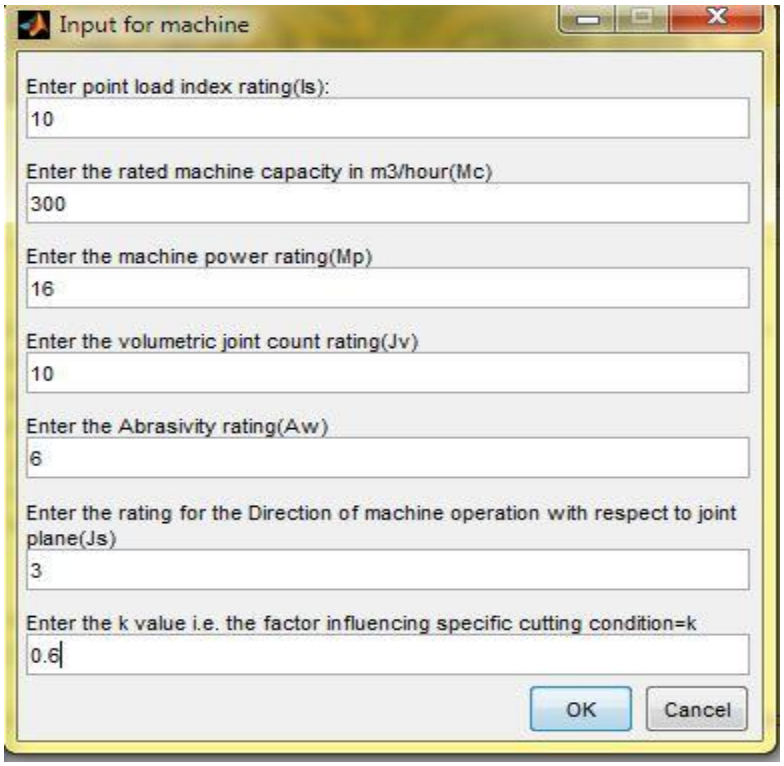


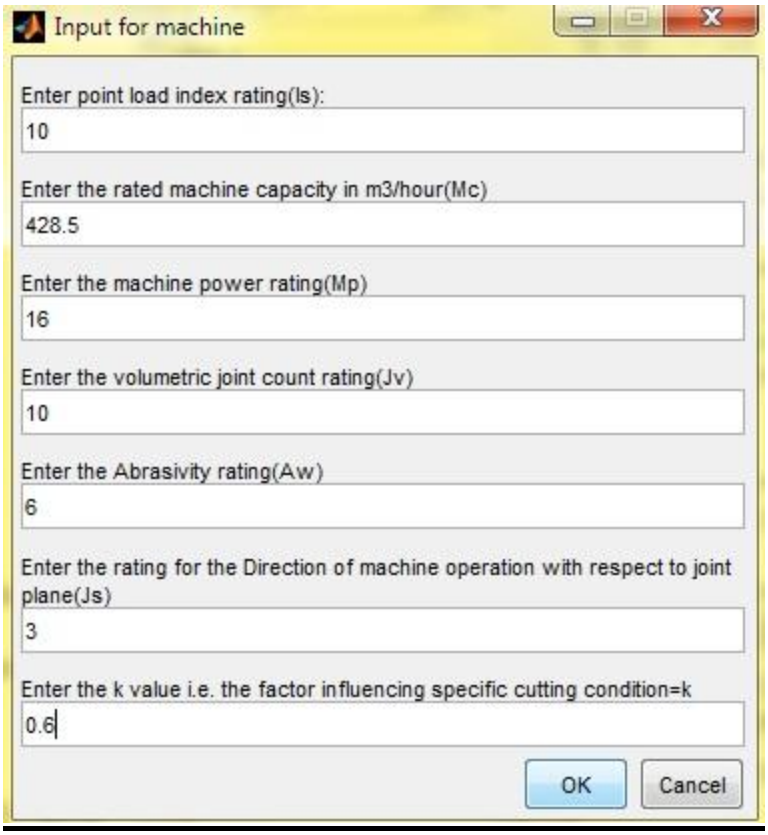
- Then we need to input datas for mines we need to compare



- Here for example we put datas for 3 mines

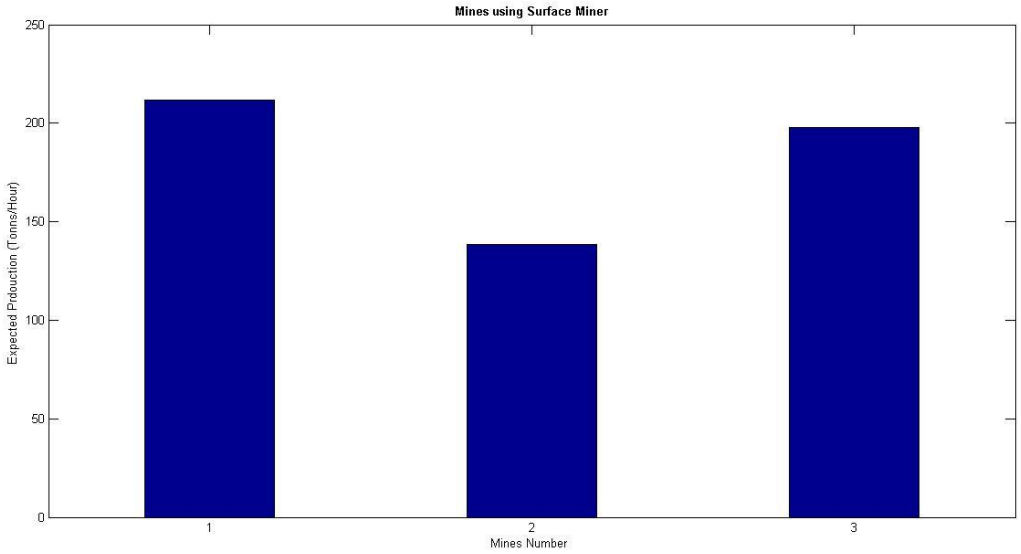






- Then program asks whether we require comparison graph or not.

- If we say yes, then production graph shows



Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

```
INPUT DETAILS FOR MACHINE NO. 3

expected_production =

  211.6800  138.6000  197.9670
```

- If no, then program ends

CHAPTER 4

Safety

Advantages of Surface Miner over other conventional machines

Safety:

There is no fire hazard to the coal seam as it never leaves behind any loose material amenable to spontaneous heating. The road becomes very smooth after every cut and thus facilitates easy movement of tippers and other equipment. The safety features of the surface miner are as under:-

1. Five nos. of engine kill switches, one in control panel, one each above the crawler units.
2. Scraper door limit switch- If the scraper door is lifted, then advance drive, drum drive and conveyor drive will be cut off.
3. Milling drum side plate warning light:- If the side plate is lifted, red warning light will start to blink to caution the operator.
4. Reverse motion warning horn.
5. Discharge conveyor slewing operation gets cut off when windrowing operation starts. Conveyor slewing can be cut off for marching/ transport for a long distance.
6. Four warning horn switches, one in control panel, one each above front crawler units.

Advantage of surface miner over conventional system of mining:

Mining by surface miner	Conventional system of mining
1.Cost of production is much lesser than conventional system e.g. in Lakhanpur OCP cost of production/tonee=Rs35	Cost of production is comparatively higher e.g. in Lakhanpur OCP cost of production/tonne =Rs 64.75
2.No requirement of drilling, blasting and crushing.	Requirement of drilling, blasting and crushing.
3.Mining is possible in close proximity of village, road and other permanent structure.	Mining is not possible due to restriction in blasting.
4.No chance of spontaneous heating and fire.	Blasting produces crack in the coal bench which leads to spontaneous heating and fire.
5.Stability of bench and high wall is comparatively much better.	Stability of benches and high wall is comparatively poor due to induced stress caused by blasting.
6.It is an environmentally friendly method of mining.	Drilling, blasting and crushing produces adverse effect on environment.
7.Selective mining is possible as a result quality of mined out coal is better.	Selective mining is not possible.
8.Thin seam mining is possible as a result non-workable seam becomes workable.	Thin seam mining is not possible.
9. Less capital investment and	High capital investment and infrastructure

infrastructure is required.	is required.
10.Top of bench and high wall is smooth	Top of bench and high wall is uneven.

CHAPTER 5

Conclusion

Scope for Future study

Conclusion:

Surface miner is a versatile and useful equipment capable of mining quality coal in highly inter-banded seams. Gathering adequate information about seam characteristics and careful planning of each cut of the surface miner combined with good supervision is the key success of grade improvement and grade control.

Deployment of surface miner has a tremendous potential of savings in man power requirement. This is possible on account of simplification and combining an array of HEMM into a single compact machine. Surface miner also facilitates better and concentrated area of supervision, since the equipment population is reduced, simultaneously ensuring higher production, improve productivity of dump trucks due to higher fill factor on account of uniform size..

The pioneering trials have bolstered the confidence of the coal industry and encourage the industry to go for larger capacity machine suitable for cutting harder coal and dirt bands in other fields of India. Using the state of art technology of surface miners coupled with rapid ash probe, opens up wide vistas of further possibilities in surface mining especially for quality enhancement without resorting to coal beneficiation.

The new cuttability index can provide a handy tool for decision making on the applicability of surface miners. It’s a good method to compare different production datas of different mines.

Scope for future study:

1. Deployment of surface miner in extraction of over burden(rock):

At present surface miner is being deployed only in coal and it is found very much economical and environmental friendly. The crushing strength of over burden in most of the coal field is less than 120 M Pa. The 3700 SM surface miner of Wirtgen make can cut the rock upto 120 M Pa. So, possibility of deployment of 3700 SM surface miner in over burden removal may be studied for future application.

2. Deployment of higher capacity surface miner in the mine:

Presently low capacity surface miner had been deployed in Indian coal mines. Daily average output of 2100 SM and 2200 SM surface miners are 6000 tonnes and 9000 tonnes respectively. Larger capacity surface miners are also available abroad e.g. 3700 SM, 4200 SM. Larger capacity surface miner may be more economical and productive in our geo-mining conditions. Proper study is required for future application.

3. Deployment of surface miner in haul road construction:

In foreign countries, the surface miners had been deployed in road construction and it was found very much successful and economical. The possibilities of deployment of the surface miner in haul road construction in Indian geo-mining conditions may be studied for future application.

4. Operation of surface miner with electrical power:

Around 65-70% petroleum and its products are being imported in our country due to low reserve. It also causes air pollution. The possibilities of running surface miner with electrical power may be studied in future so that both carbon emission and cost of production may be further reduced.

REFERENCES

Reference

[1]Ghose A. K., (2008), *New Technology for Surface Mining in the 21st Century – Emerging Role for Surface Miner*, Journal of Mines Metals and Fuels, Vol. 56 No. 3 & 4, March – April, pp. 41 – 43.

[2] Dey K., (1999), *Performance Analysis of Continuous Surface Miner in Indian Surface Coal Mine – A case Study*, Unpublished M. Tech Dissertation submitted to Indian School of Mines, Dhanbad, pp. 1 – 40.

[3] Eskikaya S. and Tuncdemir H., 2007, *A Handy Tool for Every Type of Tunneling Roadheader*, Journal of Mines, Metals & Fuels, Vol. 55, No. 12, December, pp. 524 – 538.

[4] Ghose A. K., 1996, *Rockmass Classification – A Design Tool for Mining, Civil, Engineering and Construction Industry*, Vol. 44, No. 2, February, pp. 63 – 76.

[5] Franklin, J. A. Broch E. and Walton G. (1971), *Logging the Mechanical Character of Rock,* Trans. of Institute of Mining and Metallurgy, Sec-A, pp. 1– 9.

[6] Weaver, J. M. (1975), *Geological Factors Significant in the Assessment of Rippability*, Civil Engineering in South Africa, Vol -17, pp. 313 – 316.

[7] Kirsten, H. A. D. (1982), *A Classification System for Excavation in Natural Material*, Civil Engineering in South Africa, July, pp. 293 – 307.

[8] Minty E. J. and Kearns G. K. (1983), *Rockmass Workability*, Collected Case Studies in Engineering Geology, Hydrogeology and Environmental Geology, Editors Knight, M. J. Minty E. J. and Smith R. B. Special Publication Geological Society of Australia, No 11, pp. 59 – 81.

[9] Scoble M. J. and Muftuoglu Y. V. (1984), *Derivation of A Diggability Index for Surface Mine Equipment Selection*, Mining Science and Technology, Vol. 1, pp. 305 – 322.

[10] Singh R. N., Denby B., Egretli I. and Pathon A. G. (1986), *Assessment of Ground Rippability in Opencast Mining Operations*, Mining Departmental Magazine, University of Nottingham, 38, pp. 21 – 34.

[11] Ghose A.K., Dey K, (2008), Predicting "cuttability" with surface miners – A rockmass classification approach, Vol. 56 No. 5-6, May, pp. 85-91

[12] Bernhard Schimm, (2005), Surface Miners produce annually 50 Mio. t in Indian coal fields, pp 1-8

[13] Sabanov S, Nikitin O, (2008), Risk Assessment of Surface Miner for Estonian Oil Shale Mining Industry, pp 1836-1842

[14] Pradhan Premananda, (2009), Development of a Computer Program for Selection of Opttimum mode of operation for Surface Miner

[15] http://www.wirtgenamerica.com/pdf/sm_pdf/specifications

[16] http://www.takraf.com/en/products_services/opencastminig/surfaceminer.htm

[17]Datas taken from Lakhanpur Mines, Vasundhara Mines,Talabira Mines and MCL Headquarter

[18] http://www.slideshare.net/isnindian/surface-miner-11998161

ANNEXURE-I

Machine Details of 2100 SM and 2200 SM :

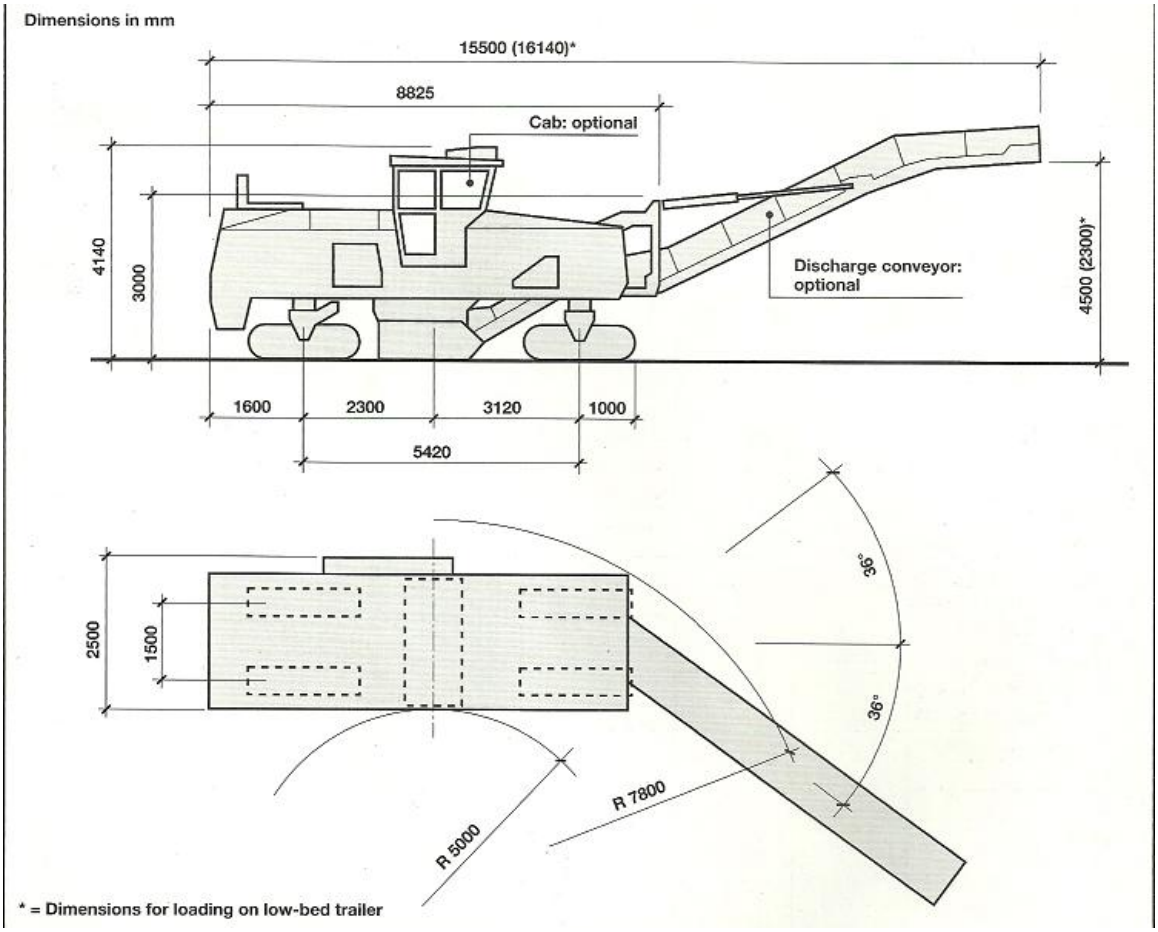
Surface Miner 2100 SM

The economic concept for cutting coal:

		Surface Miner 2100 SM	
Milling width, max.	mm	2,000	
Milling depth	mm	0-240	
Milling drum			
Tool spacing	mm	**35**	
Number of cutting tools		**76**	
Drum diameter with tools	mm	**1,050**	
Drum diameter without tools	mm	**710**	
Drum tilt, max.	o(degree)	**8**	
Engine			
Manufacturer		Mercedes-Benz	
Type		OM 444 LA	
Cooling system		Water	
Number of Cylinders		12	
Output	kW/HP/PS	448/ 601 / 610	
Speed	rpm	2,100	
Displacement	cm3	21,930	
Fuel consumption full load	|/h	110	
Fuel consumption 2/3 –load	|/h	80	

Operational characteristics		
Operating speed rang m/min	0 – 27	
Travel speed range km/h	0 – 4.6	
Theor, gradeability,travel gear %	16	
Theor,gadeability, operating gear %	47	
Ground clearance mm	350	
Weights		
Axle load, front daN (kg)	18,600	
Axle load, rear daN (kg)	18,400	
Shipping weight daN (kg)	37,000	
Operating weight, CE daN (kg)	40,500	
Track units		
Tracks, front mm	2,077 x 350 x 710	
Tracks, rear mm	2,077 x 350 x 710	
Tank capacities		
Fuel tank l	1,200	
Hydraulic oil tank l	300	
Water tank l	4,180	
Electrical system V	24	
Conveyor System		
Primary belt width mm	1,000	
Discharge belt width mm	1,000	

Theoretical belt capacity	m3/h	550	
Shipping dimensions			
Machine L x W x H	mm	8,830 x 2,600 x 3,000	
Conveyor L x W x H	mm	8,000 x 1,150 x 1,500	



Basic design:

Surface Miner for cutting rock with mechanically driven milling drum. Drum units for milling carriageway pavements**.**

Chassis:

Torsion-proof welded design with mounts for the individual components and parts, as well as integrated tanks for fuel, hydraulic fluid and water. All components are easily accessible for maintenance and repair**.**

Track suspension:

The track units are mounted on hydraulically operated telescopic guides which can be individually adjusted in height. The milling depth is set by adjusting the two rear telescopic guides. The two front telescopic guides are used to set the machine to its operating or travel position. The track units are equipped as standard with triple-grouser pads. When used as a road milling machine, it can also be equipped with rubber track pads in order to avoid damaging the road surface.

Steering:

The machine is equipped with a finger-light, hydraulic four-track steering system.

Track drive system:

All four tracks are individually driven by hydraulic motors which are fed by a common hydraulic variable-displacement pump. Speeds in milling gear and travel gear are infinitely variable from zero to maximum speed. A disconnectable differential lock ensures uniform traction. The rate of advance can be adjusted from either side of the operator's control station.

Performance regulator:

The machine is equipped with an automatic performance regulator which adjusts the feed rate in accordance with the road on the diesel engine.

The automatic performance regulator can be overridden to allow manual adjustment of the feed rate.

Brakes:

Braking is achieved by drag from the hydrostatic transmission. Automatic multiple-disc parking brakes are additionally installed.

Milling drum:

The drum operates in an up-milling direction Tool holders accommodating the cutting tools are welded onto the body of the drum.

Tool change:

The scraper blade opens hydraulically to provide access to the milling drum for tool changes.

Drum drive:

The milling drum is driven mechanically, Power is transmitted to the drum gear reducer from the diesel engine via a mechanical clutch and power bands. The power bands are tensioned automatically via a hydraulic cylinder.

Milling depth control:

The surface Miner 2100 SM is equipped with an electronic depth control system. The reference level is sensed from the milling drum side plates. The electronic depth system maintains the preselected depth by constantly monitoring and correcting the position of the depth adjustment cylinders. Slope control can also be fitted as an optional feature and simply plugs in to standard sockets.

Water sprays system:

The water spray system largely prevents the formation of dust during the milling operation and extends the life of the cutting tools,. The spray nozzles are easily removed for cleaning. Further nozzles can be installed at the conveyor discharge.

Soundproofing:

Soundproofing is fitted as standard equipment and protects both the general public and the operator from excessive noise**.**

Operator's station:

The central walk-through operator's station with dual control is located in the middle of the machine. In addition to dual control on the right and left-hand sides, the operator's ergonomic easting, low design and excellent visibility ensure easy operation. The modern operating and control elements are arranged within easy reach and within the operator's field of vision

Instrumentation:

Hour counter, tachometer, engine temperature gauge, battery charging indicator, pressure gauges for system control pressure, conveyor pressure and track drive pressure, filter contamination warning lights**.**

Hydraulic system:

Independent hydraulic systems for the individual drives and control functions. The hydrostatic pumps are driven by the diesel engine via a splitter gearbox. Filtration is achieved by return flow and feed pressure filters, as well as by pressure filters for the control functions.

Electrical system:

24-volt system with 3 phase alternator and two 12-volt batteries, starter, socket outlet for electric power, horn and complete set of working and safety lights**.**

Tank filling system:

Water is filled via a standard C-type fitting or large filling port. Diesel is filled via a standard threaded port or large filling port.

Safety features for transport:

The machine is equipped with sturdy lugs for loading by crane or for lashing to a low-bed trailer.

Conveyor system (option):

The conveyor system comprises a wide conveyor belt which takes up the cut and crushed material from the milling drum, as well as the discharge conveyor for loading the material onto trucks. The height of the discharge conveyor can be adjusted and it can be swivelled to both belts are ribbed.

Conveyor protection beam (option)

The conveyor protection beam is mounted directly in front of the milling drum. It slides over the surface and pushes away large stones or ground unevenness. It can be raised or lowered as required to avoid obstacles.

Annexure-II

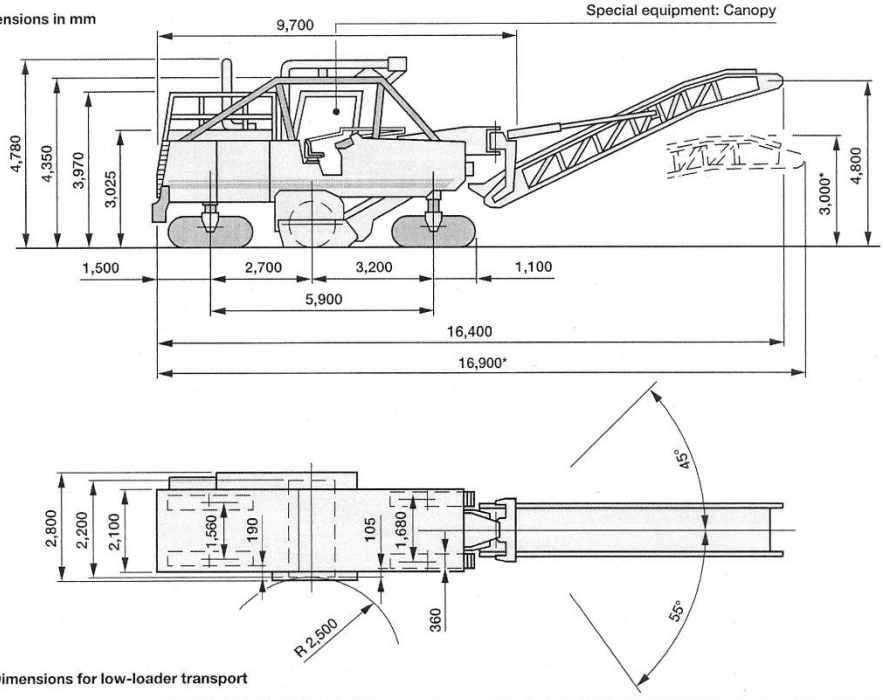
Technical specification

	Surface Miner 2200 SM
Cutting width max.	2,200 mm
Cutting depth/Windrowing mode*1	0–300/0–250 mm
Cutting drum	
Tool spacing	38 mm
Number of tools	76
Drum diameter with tools	1,115 mm
Drum inclination, max.	5°
Engine	
Manufacturer	Caterpillar
Type	C27 ATAAC
Cooling	Water
Number of cylinders	12
Output	708 kW/950 HP/963 PS
Engine speed	2,100 min^{-1}
Displacement	27,000 cm^3
Fuel consumption, full load	187 l/h
Fuel consumption, $^2/_3$ load	125 l/h
Speeds/Gradeability	
Travel speed	0 – 84 m/min (0 – 5 km/h)
Theoretical gradeability	90 %
Ground clearance	370 mm
Weights*2	
Front axle load, full tanks	25,430 – 26,105 daN (kg)
Rear axle load, full tanks	25,350 – 26,025 daN (kg)
Own weight	44,500 – 45,850 daN (kg)
Operating weight, CE*3	47,730 – 49,080 daN (kg)
Operating weight, full tanks	50,780 – 52,130 daN (kg)
Crawler track units	
Crawler tracks, front (L x W x H)	2,200 x 370 x 790 mm
Crawler tracks, rear (L x W x H)	2,200 x 370 x 790 mm
Tank capacities	
Fuel tank	1,400 l
Hydraulic fluid tank	500 l
Water tank	5,000 l
Electrical system	24 V
Conveyor system	
Belt width 1st conveyor (primary conveyor)	1,100 mm
Belt width 2nd conveyor (discharge conveyor)	1,100 mm
Theoretical capacity of discharge conveyor	668 m^3/h
Shipping dimensions/Weights*2	
Dimensions of machine (L x W x H)	9,700 x 2,800 x 3,000 mm
Dimensions of discharge conveyor (L x W x H)	8,700 x 1,700 x 1,300 mm
Upper part of operator's cabin (L x W x H)	2,550 x 3,300 x 1,500 mm
Reinforcing steel bar (L x W x H)	6,400 x 2,240 x 1,637 mm
Weight of machine	41,700 daN (kg)
Weight of discharge conveyor	2,100 daN (kg)
Weight of upper part of operator's cabin	1,200 daN (kg)
Weight of reinforcing steel bar	1,350 daN (kg)

*1 = The maximum cutting depth may deviate from the value indicated, due to tolerances and wear.
*2 = All weights refer to basic machine incl. operator's cabin and additional weight.
*3 = Weight of machine with half-full water tank, half-full fuel tank, driver (75 kg) and tools.

Dimensions in mm

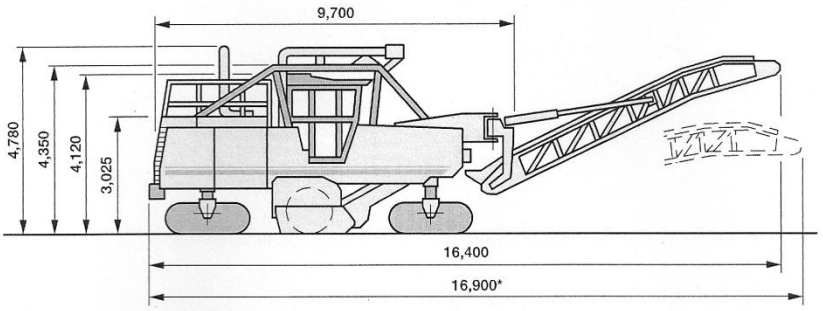
Special equipment: Canopy



* = Dimensions for low-loader transport

Special equipment: Operator's cabin and additional weight

Dimensions in mm



* = Dimensions for low-loader transport

Technical description

Basic design
The 2200 SM is a Surface Miner for cutting rock with a mechanically driven cutting drum and two-stage front loading conveyor with slewing capability and variable discharge height. The machine travels on crawler tracks.

Chassis
Robust welded construction with mounts for the individual function modules and superstructures.
The tanks for diesel fuel and water are integrated into the chassis. The hydraulic fluid tank forms a separate unit.
The hydraulically opening engine cowling, wide opening servicing doors left and right, and optimum arrangement of the individual components ensure easy access for maintenance and servicing.

Operator's platform
The walk-through operator's platform with access ladders left and right is located at the centre of the machine.
It is equipped with two separate control consoles which can be pivoted and adjusted in height.
Both control consoles and the right-hand driver's seat can be shifted sideways beyond the edge of the machine.
The control elements are located within easy reach and within the operator's field of vision. The operator's platform includes a display of the Wirtgen information and diagnosis system for monitoring the operating status of the machine.
The ergonomic sitting position, clear overview and elastically supported footboard of the operator's platform help to make the operation of the machine simple and convenient.
Steering and advance speed are governed by means of proportional control and are operated via joysticks.
As an option, the machine can be equipped with an operator's cabin.

Wirtgen information and diagnosis system and instruments
The Wirtgen information and diagnosis system WIDIS 32 provides the driver with quick and comprehensive information on the current status of the engine and the hydraulic system, generating visual and audible alarms, if necessary.
Data and messages are indicated on a multi-functional display (LC display) at the operator's platform. Other information, such as operating hours, engine speed, engine temperature or battery charge control, can be accessed here, too.
The hydraulic system is additionally monitored by two pressure gauges which indicate the actual pressures in 12 different areas of the hydraulic system.
Both air filters and the filters of the hydraulic system are monitored electrically.

Power unit
The machine is driven by a modern V 12 engine with a power rating of 708 kW/963 PS. The engine complies with the stringent requirements of the exhaust emission standards stipulated by the US Environmental Protection Agency (EPA, Tier II). It is equipped with a fully electronic engine management system which allows the engine to automatically adapt to varying ambient conditions, such as changing atmospheric pressure, temperature or humidity.
In addition, the engine offers maximum torque stability even at extreme engine loads, thus preventing breaks in operation. An extremely large cooling surface effectively cools the engine, thus allowing the safe operation of the machine even at high outside temperatures.
The power unit is additionally equipped with a fan controller. The fan speed is reduced at low ambient temperatures or low loads, thus reducing the noise emission levels.
All servicing work on the engine can be carried out from the ground.

Soundproofing
Noise levels are reduced by the standard soundproofing which also protects both the operating personnel and the environment against any nuisance due to noise.

Cutting drum drive
The cutting drum is driven mechanically by the diesel engine via a mechanical clutch and power belts acting on the drum gearbox. The three power belts with five ribs each ensure optimum power transmission due to their width, and have a long service life. The tension of the power belts is automatically maintained by a hydraulic cylinder.

Cutting drum
The cutting drum operates in up-milling direction. Toolholders accommodating the point-attack cutting tools are

welded onto the drum body. Special edge segments ensure a clean sharp cut at the edges. Additional ejectors ensure that the cut material is efficiently transferred to the primary conveyor. If the material is to remain on the ground, a flap at the scraper blade ensures that it is deposited in a windrow between the crawler tracks.
A material guide is available for this purpose, protecting the tracks from wear and tear.
The entire drum housing is made of wear-resistant material (Brinell hardness HB 400).

Cutting tool replacement
The scraper blade opens hydraulically to provide good access to the cutting drum for the replacement of tools, which can be carried out in a comfortable working position. Sufficient depositing space is provided for the cutting tool containers.

Crawler track units/Height adjustment of the machine
The crawler tracks are suspended from the chassis by means of cylindrical columns with hydraulic height adjustment. The height of each crawler track can be adjusted individually.
The cutting depth is adjusted via the two front columns, while the rear crawler tracks act as a full floating axle.
The large stroke provides a large ground clearance, thus facilitating even difficult manoeuvres, such as reversing or loading and unloading the machine onto or from a low-bed trailer.

Travel drive
The Surface Miner is equipped with large crawler tracks (5 HD) lined with double grouser track pads.
Each crawler track is driven by its own hydraulic motor.
The travel drive motors are fed by a common hydraulic variable displacement pump.
The optimum tension of the crawler tracks is maintained hydraulically.
The crawler tracks are driven automatically, thus dispensing with the need to change between cutting and travel gear.
The speed can be infinitely varied from zero to the high maximum speed.
A switchable hydraulic flow divider acts as differential lock and ensures uniform traction even under difficult conditions.
Any speed once driven can be saved in a "Tempomat" speed control and re-set, for instance, after changing trucks.

Automatic power control
The machine is equipped with an automatic power control which governs the advance speed in accordance with the engine load, but can also be deactivated.

Steering
The machine has a finger-light hydraulic all-track steering system (which can be operated from both the right or the left side of the operator's platform).
It is governed by means of proportional control, and the front and rear tracks are steered separately via joysticks.
The steering function is detached from the height adjustment by specially designed steering rings.
Tight locking angles permit an extremely small turning clearance circle.

Brake system
Braking is achieved by the self-locking hydrostatic transmission. The Surface Miner is additionally equipped with two automatic multiple-disk parking brakes at the front.

Loading the cut material
Loading of the cut material on trucks is effected to the front (front loading) by means of a wide conveyor system consisting of a primary conveyor and a discharge conveyor.
A gradation control beam largely prevents the cut material from breaking into large slabs and simultaneously protects the primary conveyor against premature wear and tear.
The discharge conveyor can load trucks from a great height. It is height-adjustable and can be slewed to both sides, thus always allowing an optimum adaptation to the conditions prevailing on site.
The high conveying speed and 1,100 mm wide, V-ribbed steep-incline belts ensure that the material is quickly removed from the drum housing.
Replacing the belts is easy due to the design of the conveyor system.

Cutting depth control/Automatic levelling system
The Surface Miner is equipped with an electronic automatic levelling system for cutting depth adjustment. It is governed